DEVELOPMENT OF AUTO RE-CLOSER EARTH LEAKAGE CIRCUIT BREAKER FOR DOMESTIC APPLIANCES

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ABSTRACT

System protection is the important requirement in electrical power system. The using of protection system can avoid and prevent system from damaged. Electrical energy has caused dangers to human life and machine. Earth leakage circuit breaker (ELCB) is one from protection device that introduced to protect the system. This device is the brain of protection system that monitors input current from power line by it sensor Zero Current Transformer (ZCT), then sending the tripping signal to mechanical switch to disconnected system. ELCB is widely applied by consumer weather is for resident, factory, laboratory and also in power distribution. Because industrial operation requires protection of their Equipment from the lightning, short-circuit and also over-current, so the ELCB will serve the purpose as the protection of their system. This project will focused to improve the ability of current ELCB so that it have ability in identify fault, act accordingly, display the fault(permanent fault and temporary fault) and also re-close it back to normal condition.PIC will execute their instruction when different current from both of current transducer is exceed pre-determine value of sensitivity,100mA. In this project PIC microcontroller will control and operate solid state relay which replacing the application of current mechanical switch.

ABSTRAK

Sistem perlindungan adalah keperluan penting di dalam sistem kuasa elektrik.Penggunaan sistem perlindungan boleh mencegah dan melindungi sistem dari kerosakan.Tenaga elektrik telah menyebabkan bahaya kepada kehidupan manusia dan mesin.Pemutus litar bocor ke bumi(ELCB) adalah salah satu sistem perlindungan yang diperkenalkan untuk melindungi sistem. Peralatan ini adalah otak bagi sistem perlindungan dimana ia bertindak sebagai pemerhati arus masukan daripada talian kuasa oleh pengesan Zero Pengubah Tanpa Arus (ZCT),seterusnya menghantar isyarat pemutus kepada mekanikal suis untuk memutuskan litar. ELCB digunakan secara menyeluruh oleh pengguna sama ada untuk kediaman, kilang, makmal dan juga pembahagian kuasa. Oleh kerana operasi industri memerlukan perlindungan mesin mereka daripada kilat, litar pintas dan juga lebihan arus, maka ELCB ini akan digunakan bagi tujuan perlindungan kepada sistem mereka.Projek ini menumpukan kepada penambah baikan keupayaan ELCB sedia ada yang mana ELCB berupaya dalam mengenalpasti kesilapan,bertindak sepatutnya, menunjukkan kesilapan dan juga menyambung kembali litar ELCB kepada keadaan asal.PIC akan melaksanakan arahan apabila perbezaan arus antara dua alat pengesan arus melebihi nilai sensitiviti ELCB,100mA. Dalam projek ini,pengawal PIC akan mengawal dan menghidupkan relay keadaan tetap(SSR) yang mana menggantikan penggunaan suis mekanikal yang sedia ada.

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LIST OF ABBREVIATIONS

AC	–	Alternate Current
ADC	–	Analog to Digital Converter
DC	–	Direct Current
I_i	–	Input Current
Io	–	Output Current
LED	–	Light Emitting Diode
LCD	–	Liquid Crystal Display
PIC	–	Programmable Intelligent Computer
SSR	–	Solid State Relay
V	–	Voltage
V_{in}	–	Input Voltage
V_o	–	Output Voltage
ZCT	–	Zero phase Current Transformer
Ω	–	Ohm

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CHAPTER 1

INTRODUCTION

1.1 Project Background

The idea of the project is refer on the problems and weakness of ELCB. Nowadays, ELCB that available in market is controlled manually and cannot turn ON automatically. Beside that, ELCB today cannot differentiate between permanent fault and temporary fault. According from that problem, it bring the problem to consumer who were not at home and do not understand the danger of permanent fault if the kind of fault happen.

This project s focused in the development and new design a unit of auto re-closer earth leakage circuit breaker (AR-ELCB).The main purpose of this project is more to upgrade the ability of ELCB. Auto re-closer ELCB can differentiate and act differently with different type of fault. The concept is easy to understand which if fault happen, ELCB will trip automatically and disconnect the circuit. If temporary fault lie lighting happen, ELCB will close back automatically and circuit is connected back in interval time that has been set. If permanent fault like electrical, electronic device or short circuit is detected, ELCB will eternally trip and permanent faulty lamp/buzzer will function as alert to consumer. When fault root cause is removed, the consumer need to manually switch ON the ELCB and that case is just especially for permanent fault.

In this project, I have planned to use the programmable interfacing controller (PIC) as control element and can make system more efficient and accurate. To get new auto re-closer ELCB, we must combined control element and old ELCB. In this combination, we must consider all power and source value for voltage and currents of each device and for it, we must know to design the new additional circuit to fix the voltage and currents which the value is suitable to interface with control element and could work together.

1.2 Objective

The objectives of this project are:

i. To develop the auto re-closer earth leakage circuit breaker(AR-ELCB)
ii. To improve the ability of earth leakage circuit breaker(ELCB) unit
iii. To notify the type of fault whether temporary or permanent fault

1.3 Scope of Project

The scopes of this project are:

i. Studied and explored about all the function of ELCB
ii. This project focused to modify and improve the ability of ELCB to assign whether permanent or temporary fault.
iii. Different output on the AR-ELCB device depend on the fault detected
iv. Development programmable interfacing controller (PIC) application as control element of circuit

1.4. Literature Review

There are two types of ELCB, the voltage operated device and the differential current operated device. For the convenience of this article only (and at the risk of causing even more confusion) I will refer to these as vELCB and iELCB. vELCBs were first introduced about sixty years ago and iELCBs were first introduced about forty years ago.

vELCB is a voltage operated circuit breaker, the device will function when the Current passes through the ELCB. vELCB contains relay loop which it being connected to the metallic load body at one end and it is connected to ground wire at the other end.If the voltage of the load body is rise which could cause the difference between earth and load body voltage, the danger of electric shock will occur. This voltage difference will produce an electric current from the load metallic body passes the relay loop and to earth. When voltage on the load metallic body raised to the danger level which exceed to 50Volt, the flowing current through relay loop could move the relay contact by disconnecting the supply current to avoid from any danger electric shock.

iELCB is current operated circuit breaker. The device will function with when the Current passes through ELCB. This current admitted to current transform device and on the load. Current from the load also admitted again to transform device. In normal state, total current applied to load is equal with total current out of the load. Because of the balance of in and out of current, it does not affect the current transform device. If there is any earth current leakage caused by earth damage, then the in and out current.[1]

In Europe, where electromechanical ELCB’s are used almost exclusively, the question of reliability of installed ELCB’s has become a subject of major concern and attention. The popular hype regarding perceived reliability of electronic components was not sufficient to prevent the major South African manufacturer, some five years ago

from changing their entire ELCB range from electromechanical to electronic technology ELCB's. The improvements in reliability that resulted from this decision are complemented by their freedom from safety performance limitations often found in lower specification electromechanical earth leakage circuit breakers. The pioneering South African developments in sensitive earth leakage protection originally used magnetic amplifier technologies to reach the required sensitive residual current tripping levels necessary for shock hazard protection in human beings. Respite the lack of maturity in electronic components during those early days, a move was made away from magnetic amplifiers to solid state electronic technology in order to overcome the identified problems of noise, size and cost. [2]

This paper traced the development of earth leakage circuit breaker and indicated the very real need for such protection against both shock hazard and fire risk. Largely influenced by the highly sensational issues of the effects of electricity on the human body. Most publicity and media coverage relating to earth circuit breaker has, quite naturally concentrated on shock hazard protection and the related life saving capabilities of the device. it is only, that understanding prevails in regard to the dramatic reduction of potential fire hazard in premises that have been fitted with sensitive earth leakage protection.[3]

Most problems in discrete relay schemes is that of contact racing and timing tolerance on pick-up and drop-off of the various relay elements within the schemes. To overcome this problem, it often necessary to add additional element, or very selective in the type relay used. Beside that, lightning never strike the same place twice. This means that in any one auto-reclose sequence several different types of fault could be present [4]

1.5. Report outline

Chapter 1 will explain about the early process before begin that project. It include the project background, objectives, scope of project and literature review. Project background is about ELCB today altogether with their problem. Objectives and scope of project is target to resolve that problem. Then, before we start that project, literature review about that device is most important to get more data and information about that device.

Chapter 2 will explain detail definition of ELCB. From that, we can find all information about that device. Beside that, we can see two type of ELCB available in market which has different characteristic and method operation. According from analytical about that device, this chapter is include the problem of ELCB with more detail.

From chapter 3,we will see the construction inside the ELCB device. It include component of Zero current transducer, black box, mechanical switch, reset button and high level resistor. From combination of that component, it will integrated together to perform ELCB operation.

Chapter 4 will explain about the development auto re-closer ELCB. It include project flow how to start that project. Other planning is proposed design circuit to replaced old circuit of ELCB. After that, we can see the flow chart how that new device is operate and how PIC application of PIC make the system more reliable and effective.

At chapter 5, it will explain about expected result and conclusion about early planning along produce the new device ELCB. From expected result, we can conclude whether the project will be successful or not.

Finally at end of chapter 6, this chapter will explain about costing and commercialization. We can estimate the cost for design one unit of auto re-closer earth leakage circuit breaker

CHAPTER 2

EARTH LEAKAGE CIRCUIT BREAKER

2.1 Introduction

This chapter describe about nowadays earth leakage circuit breaker that used in 240Vac for domestic appliances. Before start any project about that device, it is important to analyze and understand the basic of the ELCB device and know how the device work actually. To achieve the objective for this chapter, the research of earth leakage circuit breaker is done by exploring the 240Vac ELCB that normally used for domestic appliances.

The objectives of this chapter are:

i. To know the system of basic Earth Leakage Circuit Breaker
ii. To understand how the device work
iii. To analyze the problem of ELCB

2.2. Earth Leakage Circuit Breaker (ELCB) Device

An Earth Leakage Breaker (ELCB) is devices that detect leakage current and protect consumer from electric shock if leakage current occurred. the device is used to

directly detect current leaking to earth from and installation and cut the power. For example, if any fault happens, ELCB will detect and trip, so the electrical supply is disconnected.

ELCB must fitted in main switchboard in every home to prevent electric accident and this is very effective way. If we using electric water heater equipment, additional ELCB need to be specially fixed in order to monitor the heater water. This precaution is god in ensuring your house safety.

There are two type of ELCB mostly used and available in market. That type is voltage earth leakage circuit breaker (vELCB) and current earth leakage circuit breaker. Few years ago, the was vELCB is mostly used, but its utilization was currently had been abolished because it was less effective. Then, iELCB is introduced to replaced vELCB immediately. The iELCB is more sensitive to any damaged in assembly and electrical appliances at domestic

2.2.1 Voltage Earth Leakage Circuit Breaker (vELCB)

vELCB is a voltage operated circuit breaker, the device will function when the current passes through the ELCB. The principle of operation of the vELCB is as follows. Under normal conditions the closed contacts of the vELCB feed the supply current to the load. The load is protected by a metal frame, such as in an electric cooker. The vELCB also has a relay coil, one end of which is connected to the metal frame and one end connected directly to ground. A shock risk will arise if a breakdown in the insulation occurs in the load which causes the metal frame to rise to a voltage above earth. A resultant current will flow from the metalwork through the relay coil to earth and when the frame voltage reaches a dangerous level, e.g. 50 volts, the current flowing through

the relay coil will be sufficient to activate the relay thereby causing opening of the supply contacts and removal of the shock risk.

As can be seen from the above description, this type of ELCB is essentially a voltage sensing device intended to detect dangerous touch voltages. The level of shock protection provided by the vELCB was somewhat limited as these devices would not provide shock protection in the event of direct contact with a live part. An additional problem with the vELCB was its tendency to be tripped by earth currents originating in other installation

2.2.2 Current Earth Leakage Circuit Breaker (iELCB)

The iELCB was introduced in the late 1950's. It operates on the following principle. Under normal conditions the closed contacts of the iELCB feed the supply current to the load. The load conductors are passed through a current transformer (CT), a doughnut shaped device. The load conductors act as primary windings of the transformer. The CT is fitted with a secondary winding. Under normal conditions, the total current flowing from the supply to the load will be the same as the total current flowing back to the supply from the load. As the current in both directions is equal but opposite, it has no effect on the CT. However, if some current flows to earth after the iELCB, possibly due to an earth fault, the current flowing to the load and from the load will be different. This differential current will cause a resultant output from the CT. This output is detected and if above a predetermined safe level, it will cause the iELCB to trip and disconnect the supply from the load.

2.3 Problem of ELCB

Earth leakage circuit breaker is one type of device used especially as a protection device. The main function of ELCB is to cut off the electrical supply when the fault is detected. But, the disadvantage for ELCB device nowadays, it cannot turn on itself and back to normally condition if fault occurred. To connect the electrical supply back, the consumer must turn on manually. But, if any person not in home, the electrical supply is remain in turn off condition.

Beside that, ELCB cannot recognize fault whether temporary fault or permanent fault. The principles of operation just to trip and disconnect circuit, but it actually not recognize the type of fault. The ELCB will trip depend on temporary fault only and for permanent fault problem, there is no output is created to ensuring the consumer safety.

The device is also cannot act differentially for these two types of fault. ELCB device just detect and trip depend on temporary fault only. If permanent fault happen, the consumer know the root of that problem and can see the reaction from ELCB. But in permanent fault case, there is no output showed at ELCB, so it can create the danger like electrical shock and other problem to consumer.

2.4 Electrical Fault

A fault is any abnormal situation in an electrical system in which the electrical current may or may not flow through the intended parts. Also equipment failure attributable to some defect in a circuit (loose connection or insulation failure or short circuit etc.). Types of faults in a distribution network circuit are:

i) Over-load